Evaluation of Innovative Investment Projects in the energy sector

Olga Pyataeva[1][a], Valentina Britvina[2][b], Anna Zueva [3][c], Elena Borisova[1][d] and Oleg Skryabin[4][e]
[1] *Russian State Academy Of Intellectual Property, 55a Miklukho-Maklaya str., Moscow, Russia*
[2] *Moscow State Polytechnic University, STANKIN, 38 Bolshaya Semenovskaya str., Moscow, Russia*
[3] *Lomonosov Moscow State University, 1 Leninskie Gory str., Moscow, Russia*
[4] *National Technological University MISIS, 4 Leninsky pr., Moscow, Russia*
o.pyataeva@rgiis.ru

Keywords: Innovation investment projects, Technological forecasting, Generating companies, Obsolescence, Energy sector, Index method.

Abstract: The article provides theoretical provisions and practical examples of technological forecasting in the context of planning and calculations efficiency indicators for energy enterprises. This method is recommended primarily for innovative projects because of methodological difficulties in predicting the results of the "innovative" component effect when planning innovations.

1 INTRODUCTION

The article will consider the role of technological forecasting in planning and calculating indicators of energy enterprises and also examples of such type of forecasting. Technological forecasts (which allow using not only investment, but also innovative characteristics of equipment as a base for analysis and all possible deviations and risks of uncertainty in this case) are all the more relevant because of morally and physically outdated of equipment and other fixed assets.

2 MANUSCRIPT PREPARATION

As practice shows, the main method of assessing the degree of outdate in Russia and especially abroad is an accounting of physical deterioration when comparing the useful life and the working life of assets. In this case it can be used the “useful life of fixed assets laid down in the calculation of depreciation rates for full recovery” indicator as a “working life of assets” (Kuzmin, 1997). Using this type of methodology usually leads to a following situation: the depreciation rates becomes much higher than the estimated (normative) depreciation rates; the last one in turn is the basis for carrying out renovation measures at energy enterprises. It seems that the solution to this contradiction should be changing the methodology for assess depreciation rates with appropriate fixing it in the regulatory and methodological documents.

It is important to take into account the following: replacing outdated equipment with completely identical one can not have fundamentally consequences for energy enterprises because of obsolescence in additional to physical depreciation. According to various scientists and researchers (including E.Ametistov, V.Fomina, P.Rogalev, A.Zubkova and others) almost all the condensing heat and power capacity in Russian energy sector is obsolete. This circumstance was emphasized by L.Gitelman who said that “new types of power equipment with higher technical and economic characteristics appear than equipment of similar quality are devalued” (Gitelman L., Ratnikov B., 2002). Energy enterprises using equipment with lower technical and economic characteristics lose out in a competitive market. The term “obsolescence”

[a] https://orcid.org/0000-0001-6373-1642
[b] https://orcid.org/0000-0001-6528-6845
[c] https://orcid.org/0000-0002-7733-2930
[d] https://orcid.org/0000-0003-1362-5213
[e] https://orcid.org/0000-0002-0965-1454

means in this way "the loss of value due to scientific and technological progress and increased productivity" of buildings, structures, machines, automata and other equipment. Thus, "constant revolutions of the means of production" (Guidelines for evaluating investment projects, 1999), which are increasing along with "the capitalist mode of production" and dictate the necessity of "constant compensation their obsolescence, which occurs long before they physically expire". In accordance with Karl Marx's publications these regularities are the basis of modern capitalism, and the rate of scientific and technical progress only accelerates upon change of technological structures in the last hundred years (Guidelines for evaluating investment projects, 1999).

It appears that obsolescence "is expressed in the wear of equipment before the end of their physical life as a result of puts new products and cost-effective types of equipment on the market" (Rogalev P., Zubkova A. and Masterova I., 2005). The rate of retirement due to obsolescence is determined by the pace of technological progress in the industry. Correct assessment of it allows to determine the optimal moment for upgrading or replacing outdated equipment. In relation to distribution and generating power plants "obsolescence" is expressed in significantly higher fuel consumption for electricity generation. Obsolete equipment has worse reliability indicators and less maneuverability than improved units of equipment (Rogalev P., Zubkova A. and Masterova I., 2005).

Further the authors give a gradation of obsolescence's degrees, which it seems appropriate to take as a basis for further comparisons. Thus, obsolescence show itself in several forms: hidden (occurs at the beginning of development of a new model of equipment); partial (from the beginning of mass production of a new model); full (the main position of the new model in the fleet of existing equipment, when it can be replaced to the park of "obsolete machines"; it is not removed usually in energy sector but transferred to "high operation mode" or to reserve (Rogalev P., Zubkova A. and Masterova I., 2005).

The amount of obsolescence is determined by the ratio of operating parameters of new and existing equipment: power of the unit of equipment; efficiency; technical resource; share of the unit; environmental characteristics.

The level of obsolescence of a unit of equipment can be calculate using the formula:

$$\mathrm{O}_{\%} = \frac{\mathrm{LV}}{\mathrm{P_o}} * 100\%$$

$$\mathrm{LV} = P_o - P_N * \prod_{i=1}^{n} \beta_i$$

where $O_{\%}$ – level of obsolescence of existing equipment, %; LV - loss of value when outdating unit due to obsolescence; P_O, P_N - prices of the old and new units; ßi - a coefficient reflecting the ratio of the operating setting for new and old equipment (ß < 1.0 if new technology is better old; ß > 1.0 when a new technique is worse than the old); $\prod$ - sign of the product; n - the number of considered operational parameters of the equipment for this purpose.

According to V.Fomina it can be allocated two forms of obsolescence: the first type (the production begins to cost less as the result of productivity growth, appears exactly the same equipment at a lower price) and second type (on the market facilities of the same purpose, but with improved technical and economic characteristics. As a result old units of equipment not even fully worn-out prevent the general increase in labor productivity).

Formula for calculating the first type of obsolescence is given below:

$O_1 = RC^{t-1} - RC^t$

where

MO_1 – the amount of first type of obsolescence, RC^{t-1} - replacement cost of the previous revaluation; RC^t - replacement cost of the revaluation at the current moment.

The amount of replacement cost of revaluation at the current moment should be less than the replacement cost for the previous time of revaluation.

Formula for calculating the second type of obsolescence is given below:

$$\mathrm{O}_2 = RC_0 - RC_1 * \frac{G_0 * T_0}{G_1 * T_1}$$

where

MO_2 – the amount of second type of moral obsolescence, RC_0 - replacement cost of the previous revaluation; RC_1 - replacement cost of revaluation at the current moment, G_1 and G_0 - annual electricity generation by existing and new fixed assets, T_1 and T_0 - the useful lives of existing and new fixed assets, years.

According to the authors of this article all these methods do not let to calculate a completely correct value of the indicator of obsolescence because the replacement cost is the amount of expenses necessary to restore worn-out fixed assets, calculated based on current prices; thus, it will include the amount of both obsolescence and physical depreciation.

As a solution to this contradiction one of the authors in his earlier publications proposed to define second type of obsolescence as the difference between the inventory value of existing and new operating systems, adjusted for the performance (production) of existing operating systems.

$$\mathrm{O}_2 = IV_0 - IV_1 * \frac{G_0 * T_0}{G_1 * T_1}$$

where MO_2 – the amount of second type of moral obsolescence, IV_0 and IV_1 - inventory value of existing and new fixed assets, G_1 and G_0 - annual electricity generation by existing and new fixed assets, T_1 and T_0 - the useful lives of existing and new fixed assets, years.

The proposed mechanism, however, is not applicable if there is an additional parameter of “innovation” (when the project is “innovation-investment”). The authors of this article consider it appropriate forecasting innovation performance by comparing the value of investment on early replacement of the facility upon expiration of obsolescence and relevant indicators in relation to the old objects using the criteria of minimum cost, maximum effect and maximum profit (Filatov A., 1997).

Despite the indisputable practical significance of the above methods, they allow to evaluate the parameters that already achieved (for example, the number of years obsolescence occurred, provided that this period has already expired). However, in practice of evaluating innovative projects there is often a situation when it turns out to be more promising to implement equipment that has a shorter year of development and start of serial production than the alternative.

The authors propose to resolve this contradiction by adding an indicator of equipment obsolescence to the methodology for calculating the effectiveness of innovations (and more specifically, innovation and investment projects in the energy sector). In this case, we are talking about forecasting the technical and technological parameters of innovations (that is, in fact, the previously mentioned technological forecasting, endowed with all the characteristic properties described above). A.Ilyshev, N.Ilysheva, I.Voropanova (Ilyshev A., Ilysheva N. and Voropanova I., 2005) give methods for evaluating the possible timing of maintaining competitive advantages when fundamentally new types of products or technologies are creating based on the agreed opinion of experts.

The methodology of expert research generally includes the construction of evaluation scales, organization, conduct, processing of survey results, obtaining ratings / analyzing results.

At the second stage, each of the experts was interviewed to get their estimates of the possible period of maintaining competitive advantages and the degree of demand for innovation.

The analysis of the questionnaire results begins with the compilation of a summary table. At the intersection of each row and column, the position assigned to the features by the expert is indicated.

In order to improve the consistency of experts' opinions it is possible to conduct a second round of expert survey and add "degree of novelty" indicator to the list of assessments and therefore the importance of the “obsolescence” indicator in this case.

A ten-point scale for assessing the degree of innovation (D) is included the following situations:

- implemented for the first time in the world – 10 points;
- implemented for the first time in the country – 7 points;
- implemented for the first time in the region – 5 points;
- implemented in the form of improvements to a previously created project – 2 points.

In this case, the gradation of the degree of prospects for innovative investment projects is based on a combination of the timing of maintaining the competitive advantages and the average level of demand for project results over the corresponding period of life cycle.

An example of a possible combination of two project prospects for energy company is given below.

Table 1: Combinations of the number of hours using a power plant and timing of maintaining the competitive advantages when implementing innovations in thermal power plants.

Timing of maintaining the competitive advantages, T, years	Time ranged in years	The number of hours using a power plant (% of annual values), N				
		1	2	3	4	5
		below 60	61-70	71-80	81-90	91 and more
1	15-17	1,1	1,2	1,3	1,4	1,5
2	17-21	2,1	2,2	2,3	2,4	2,5
3	21-24	3,1	3,2	3,3	3,4	3,5
4	24-27	4,1	4,2	4,3	4,4	4,5
5	27-30	5,1	5,2	5,3	5,4	5,5

In the table, oblique lines delimit the combinations of two features that form gradations of the number of using a power plant perspective degrees. In this example the dependence of obsolescence for thermal power plants is shown in the table of compliance. It is shown the degree of prospects for the values of innovation investment project at the intersection of the table.

Table 2: Gradation of degrees of prospects for innovation and investment projects (by a combination of two features).

The degree of perspective of innovation investment		Combining the timing of maintaining competitive advantages and the relevance of innovation investment project results
Code	Name	
A	Top	5,5; 5,4; 4,5
B	Very high	5,3; 4,4; 3,5
C	High	5,2; 4,3; 3,4; 2,5
D	Above-	5,1; 4,2; 3,3; 2,4; 1,5
E	Average	4,1; 3,2; 2,3; 1,4
F	Below the	3,1; 2,2; 1,3
C	Very low	1,1; 1,2; 2,1

In this case the calculation of the table indicators (each of which corresponds to a certain degree of demand (prospects) for equipment) will be carried out using the following formula:

$$P = N * T * D$$

where P – a degree of prospects for innovation and investment projects, N – The number of hours using a power plant, % per year; T - timing of maintaining the competitive advantages; D - the degree of innovation of the innovation investment project, units.

3 CONCLUSIONS

This method is recommended primarily for innovative investment projects because of methodological difficulties in predicting the results of the "innovative" component effect when planning innovations.

REFERENCES

Ametistov, E., 2004. Fundamentals of modern energy: A course of lectures for managers of energy companies. *Moscow power engineering Institute (Technical University)*. 134-136.

Concept of development of innovative activity in the electric power industry, (2008) *Moscow*.

Filatov. A., 1997. On the obsolescence of electric power facilities. *Electric stations*. 9, 68-72.

Gitelman, L., Ratnikov, B., 2002. Effective energy company: Economy. Management. Reformation. *Moscow. Olymp-Business*. 45-59.

Guidelines for evaluating investment projects, 1999. *Moscow*.

Ilyshev, A., Ilysheva, N., Voropanova, I., 2005. Accounting and analysis of innovation and investment activities: Textbook for universities. *Moscow*. 133-138.

Kuzmin, V., Bormogova, Z., 1997. Economic problems of wear and tear of equipment for thermal power stations. *Electric stations*. 9, 64-65.

Marx, K., 1999. Capital. 2, 49, 213-219.

Rogalev. P., Zubkova, A., Masterova, I., 2005. Economics of energy: textbook. Manual for universities. *Moscow power engineering Institute (Technical University)*. 347-349.